THE POPULATION PROJECTIONS PROGRAM
of the
Colorado Division of Local Government

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The Demographic Section of the Colorado Division of Local Government annually prepares population projections for the state, for all regions, and for all counties of the State. These projections include data by gender and by single year of age -- which can be aggregated into any age groupings -- for all or any selected years from 1990 to 2035. They are used by state and local governmental agencies in planning for various projects and programs and by various businesses and non-profit agencies in analyzing and anticipating changes in their markets. The following describes the overall system of procedures, methods, and assumptions that go into the preparation of these projections.

Overview of the Projection System.

The population projections are produced by an economic-demographic system which models the intra- and interrelationships of demographic and economic change at the county, region, and state level. The overall process can be summarized as follows: A series of separate procedures involving two distinct models, one demographic and one economic, projects the supply and demand for labor, respectively, in a region's economy for the projection period.

The **supply** of labor is projected in two steps. A cohort-component, demographic model survives the resident population forward in time based on specified fertility and mortality assumptions. Assumed age-sex-specific labor force participation rates are then applied to this population to create the indigenous supply of labor.

The **demand** for labor is projected by an econometric model which relates the region's industrial structure to demand for that sector's output at the state and national level.

Where demand for labor exceeds supply, **equilibrium** is restored by migrating people into the region. Where the supply exceeds demand, out-migration is assumed to occur. Thus, the bulk of the amount of migration to or from a given region is determined by projected labor supply and demand at each period.[1]

The Middle-Up, Middle-Down Approach

Until three years ago, the projections were prepared at the county level. Hence, the state and the regions projections were merely the sum -- the "bottom up" -- of the composite counties. This approach was taken in order to produce credible county projections, which is one of the important responsibilities of the program. However, this county-oriented approach made the interpretation of the regions, and in particular, the state projections quite cumbersome. As there are many users of these projections that focus directly on the state forecast itself and on state demographic inputs such as fertility and migration, this sum-of-counties approach was not satisfactory to them. Hence, a need has existed for an approach which would produce credible state and region projections as well as county projections.

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[1] However, not all of the migration to or from a particular region is determined by economic forces. Separately, and in advance of this determination of this migration due to economic forces, the non-economic in- and out-migration of certain age-sex groups -- primarily retirees and young adults (from rural areas) -- is projected.

The approach chosen to overcome this problem -- the **"middle-up, middle-down"** approach -- prepares the projections at a region level. In this approach, all counties within a specially-defined projections region use the same assumptions regarding the rates used in the model (fertility, outmigration, and labor force participation)[1]. Thus, the sum of the projected county populations (and net migrants), not only in total but also by age and sex, equals that of the region. This makes the problem of fitting the parts, -- now nine (9) projection regions instead of 64 counties -- to the state whole a lot easier than in the past. (They and their constituent counties are shown on page 3.)[2]

The Demographic Model

The basic framework for determining the population and by age-sex is a classic demographic "cohort-component" model. As its name implies, this type of model projects the basic components of population change separately (deaths, births, and migration) while maintaining the age-sex detail of the population. In the first step of the basic operation of the model for each year, the number of people in each group is "survived" -- deaths are subtracted -- to the next year and the next age group. For example, 0 year olds in year 1 become 1 year olds in year 2, 1 year olds become 2, etc.. Fertility rates are then applied to the women of child-bearing age (15 - 49) to produce a new birth cohort for the year. Age-sex specific labor force participation rates are applied to the population 16 and over to estimate the total labor force provided by the existing population. Finally, migrants are added or subtracted from each age-sex group to achieve a population sufficient to supply a labor force demanded by the economic forecast.

The data requirements for running the demographic model are: A) survival rates by age and sex, B) fertility rates for women 15 - 49, C) the age-sex distribution of net migrants, D) base year population disaggregated by age and sex, E) the age and sex of the special populations of military, prisoners, college students, and temporary ski populations, and F) labor force participation rates by age and sex. The model allows for changes in survival, fertility, and labor force participation rates as well as migration rates and/or amounts over time. The specific data and assumptions used in running the model for these projections are described below.

Questions about particular aspects of these data should be addressed to either Cindy DeGroen (866-3004) or Jim Westkott (866-3190). This model can be run for any age group or combination of age groups, and for any county or region or combination of counties or regions to any year up to 2030. Remote computer access to model output is available to subscribers to CEDIS (Colorado Economic and Demographic Information System), the Division of Local Government's online data service.

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[1] Needless to say, the regions are formed by grouping those counties whose fertility, outmigration, and labor force participation rates are very similar. Thus, the uniqueness of the rates of the counties is not significantly lost by these aggregations.

[2] While there was not enough time to adjust the regions' projections to a state projection and vice-versa in the most recent run, the procedure is now possible and will be used in the future. In it, a state run with statewide demographic inputs will be com-pared to a sum-of-regions projections. Then, state and/or region inputs -- primarily, the age-sex distribution of the in- and out migrants and the special populations) will be adjusted so that the results (by age) of the two projections will be nearly identical.

The Economic Model

The county employment and labor force forecast is prepared in several steps by the Center for Business and Economic Forecasting (CBEF), affiliated with Regis University, in cooperation with the Demography Section. In the first step, nonagricultural wage and salary employment, employed persons, and labor force for the state as a whole are forecast. The preparation of this forecast is described below.

The Colorado forecast through 2000 is based on CBEF's most recent short-run economic forecast. The Colorado forecast after 2000 is based on CBEF's long-term model. This model is an annual model which incorporates econometric relationships between Colorado and U. S. economic variables and Colorado demographic parameters.

Labor demand is forecast for Colorado industries based on econometric relationships between employment in that industry and either Colorado or national economic variables. For example, employment demand in retail is based on Colorado retail sales while employment demand in some manufacturing sectors is based on national capital goods spending, among other variables. This is because retail trade depends on the local market while some manufacturing sectors sell in national or world markets. Labor supply is based on population by age and sex and labor force participation rates for the different age-sex cohorts. The population forecast, at this stage, is generated within the CBEF model. It is later adjusted for consistency with the Demography Section's cohort-component model.

The CBEF model estimates labor supply and labor demand; then adjusts labor force participation and migration to bring supply and demand into balance. These supply-side adjustments can be constrained. For example, in the most recent forecast, net migration to Colorado was limited to 1.4 times the state's share of net immigration into the U. S. in 2001 with the share dropping to 1.1 times Colorado's share in 2030. Changes in labor force participation are constrained so that the Colorado (total) labor force participation rates decline, at most, 0.5 percent per year. If labor supply, possibly constrained, is not sufficient to meet labor demand, then labor demand is reduced.

The CBEF model forecast for state nonagricultural wage and salary employment is then converted to the jobs concept used at the regional and county level. This concept referred to as "ES202+" employment includes jobs reported for unemployment insurance tax plus military plus farm jobs. Then ES202+ employment, employed persons, and labor force growth projected in the long-term state forecast are allocated among eight regions in the state. These regions are combinations of the state's 14 planning and management regions reflecting some degree of economic homogeneity.

ES202+ employment growth is distributed to regions, then within regions to counties based on "capture rates". The capture rate is the share of new jobs in a larger area (state or region) which are "captured" by the smaller area (region or county). Capture rates estimates reflect historical growth patterns, judgment and knowledge about future developments in various areas of the state. For example, capture rates are adjusted to include the effects of major new employers. For counties in the Denver metropolitan region, county capture rates are based on the most recent allocations of growth among counties as prepared by the Denver Regional Council of Governments.

After ES202+ employment for regions and counties is estimated, employed persons are calculated by assuming that the ratio of employed persons-to-ES202+ employment in each region (county) changes in the same proportion as the corresponding ratio for the state (region). A similar procedure is applied to the number of unemployed persons, projecting the unemployment rate for each region (county). Employed persons and unemployed persons are then summed to equal the labor force. The estimates are then adjusted to state totals. The labor force estimates are also adjusted to incorporate such factors as changes in commuting patterns.

Stages in the Preparation of the Population Projections

The overall set of population projections is produced in a series of stages which are carried out at the state, and then region and county levels. They are as follows:

Creating the State Forecast

1. First, a draft state level economic forecast is prepared using the CBEF model. The model, as constructed, provides a forecast of employment (by industrial division at the state level only), employed persons, unemployed persons, (and thus,) persons in the **labor force (demanded** by the economy), and personal income. The model also forecasts approximate levels of **net migration** and population which are used internally to forecast activities in the construction and consumer service sectors of the economy.

2. In step #2, the levels of net migration forecasted by the economic model are used in the demographic model to create a first draft population forecast. Then, the forecast populations by age and sex are multiplied by projected age-and sex-specific labor force participation rates to produce an initial forecast of the labor force (supply).

3. In step #3, this demographically-produced labor force supply is compared with the labor force (demand) generated by the economic model and an attempt is made to reconcile the differences that result from the running of the two models. Initially it is assumed that the demographic model correctly forecasts the labor supply for various levels of net migration and thus population. Thus, the relationships related to net migration and/or labor force demand in the economic model are adjusted slightly in the direction that would bring the labor force demand closer to the labor supply projected by the demographic model.

   If these adjustments do not bring the labor force demand in line with the projected supply then consideration is given to changing certain assumptions in the demographic model. The two assumptions most likely to be considered are the labor force participation rates and the age-sex distribution of migrants. The adjustments, however, large or small, are based on what seem to be the most reasonable assumptions given what is known about the economy and the natures of the two models. Generally, the results of the models can be brought into an alignment -- where labor force supply projected by the demographic model equals the labor force demand projected by the economic model without having to make unreasonable assumptions.

Creating the Region and County Forecasts

4. In step#4, the region and county economic forecasts are prepared:

4A. In step #4A, economic forecasts of jobs are prepared for each of the state's planning and management regions, and then for the counties within them. In general, these forecasts are based on the region's share historically of the state total, and then the county's share of the region total. However, where more detailed economic analysis exists, the job forecasts are developed in two stages: In the first, the region's or county's share of the state total is determined for each of the area's basic industries. Then, its non-basic industries are projected on the basis of historical levels of these industries in relation to the base industries for these areas.

4B. In step #4B, the number of employed persons by region and by county are forecasted on the basis of the forecasted number of jobs. First, because the number of jobs is by place of work and the number of employed persons is by place of residence, the forecast (of employed persons) needs to account for existing and expected patterns of commuting between counties. In addition, these

forecasts need to account for the number of multiple job holders. (One employed person can hold more than one job.

4C. In step #4C, the labor force (demand) forecast is prepared on the basis of the jobs-employed persons. This is achieved by forecasting an unemployment rate and thus the number of unemployed persons, and by adding together the forecasts of employed persons and unemployed persons.

5. In step #5, the region and county population forecasts are prepared:

5A. In step #5A, the initial region and county population forecasts are prepared on the basis of historic, current, and anticipated levels of net migration.

Adjustments are made in the region's and state's assumed age-sex distribution of migration. As was explained in the section on page 2 regarding our "middle-up, middle-down" approach, there is a need to fine tune these assumed age-sex distributions of migrants so that the sum of the regions for each age group approximates the size of the age-sex groups that result from a state-level projection. It is at this point that this work is done.

A committee of state agencies have been formed to assist staff in the reviewing and evaluating the age-sex population forecasts. These agencies, as part of their service responsibilities, monitor the existence of age-sex specific conditions or activities which are often reflective of the amounts of populations in certain age-sex groups.

5B. In step #5B, initial labor force (supply) forecasts are prepared at the region and then county levels based on the initial population forecasts and forecasts of regional age-sex-specific labor force participation rates.

6. In Step #6, the initial forecast of the demand for labor is compared to the initial forecast of the supply of labor at first the region and then county levels. Adjustments are then made in the economic and/or demographic forecasts and/or the projected labor force participation rates so that the forecasts of labor force demand equals that of labor force supply. At this point, staff-produced **preliminary** economic and population forecasts have been completed.

7. In step #7, the preliminary economic and demographic forecasts are reviewed at the region (and county) levels. While potentially all assumptions contained in either model are subject to review, the primary focus will be on the forecast for several key variables; namely: jobs, employed persons, labor force (demand), net migration, and labor force participation and the resulting labor force supply. It is not expected that initially these numbers will all fit together. The review will most likely lead to revisions in some of the assumptions and in the forecasts of some of the key variables.

Detailed Descriptions of Assumptions and Data Sources
Used in the Preparation of the Demographic Model

The Demographic Section has made a number of estimates and assumptions in applying this model to Colorado and its counties. These are described briefly below:

Survival Rates. The number of deaths in each projection year is calculated by applying a survival rate to each single year age-sex group. Base year survival rates are derived by calculating annual average age-sex specific death rates. Resident deaths for one-half of 1999 and all of 2000 constitute the numerator and the 2000 (April 1) Census population the denominator for each age-sex group. Survival rates are assumed to improve slightly over time, maintaining their current ratio to rates projected by the Census Bureau for the U. S. (Current Population Reports, Series P-25, No. 1092, to be released in early, 1993). Expectation of life at birth for Colorado males is assumed to increase from 73.6 years in 1990 to 76.4 years in 2020. Comparable figures for females are 79.7 years in 1990 and 82.4 in 2020. A single set of survival rates is used for all counties in the state.

Fertility Rates. The number of births in each projection year is calculated by applying age-specific fertility rates (by five year age groups) to the resident female population 15 - 49. Fertility rates are derived by calculating the annual average fertility rate using resident births for one-half of 1999 and all of 2000 as the numerator and the 2000 (April 1) Census female population in each age group as the denominator. The total fertility rate for the State is 1995 births per 1000 women 15 - 49 and, consistent with national projections of fertility rates, is expected to remain constant throughout the projection period.

Because there is much greater regional variation in fertility rates than survival rates different fertility rates are used for different regions in the state. Thus, region-specific fertility rates were calculated and used in the model. The fertility rates for each region and the region's constituent counties are shown in the table on the next page. The rates are shown for both when the special population women are excluded and when they are included. The former rates (which excluded the special population women, primarily college students) are the rates used in the model since the special population women are not included in the female population that generates the births in the projection model.

Migration. As described above, the current application of the model sets future net migration levels for each geographic unit -- except counties in the Denver metropolitan area (CMSA) -- such that the supply of labor is equal to the demand for labor forecast by the econometric model. The levels are set at each five-year interval, and then interpolated for the intervening years, such that the average of the annual differences between the demand and supply of labor over the period approximates zero.

The assumed age-sex distribution of migrants is estimated on the basis of prototype patterns by age and by a "residual analysis" of population change. In the latter analysis, the age-sex distribution of migrants is estimated by surviving forward from the 1980 Census population (adjusted for estimated undercount), subtracting actual deaths (by age and sex), and adding actual births (by sex, and by year of birth) to create an expected 1990 population by age and sex. The difference between the expected (survived plus born) population and the population enumerated in the 1990 Census is assumed to represent net migration by age and sex for the decade. (It is expected that these estimates will be updated using 2000 Census data in the coming year.) This distribution is scaled to the projected annual net migration total to achieve the projection year age-sex specific migration pattern.

Total Fertility Rates by Region

PROJ. REGION	COUNTIES	TOTAL FERTILITY RATES		
		Excl. Special Pop.	Incl. Pop.	
1. Denver-Bldr CMSA	Adams, Arapahoe, Boulder, Denver, Douglas, Jefferson		2092	1955
2. Region 2	Larimer, Weld		2144	1773
3. Colo. Sprgs. MSA	El Paso		2399	2293
4. Pueblo MSA	Pueblo		2188	1983
5. N. Central Mtns.	Clear Creek, Gilpin, Eagle, Grand, Jackson, Pitkin, Routt, Summit		1969	1594
6. Northwest Colorado	Garfield, Mesa, Moffat, Rio Blanco		2196	2028
7. SW Colorado	Delta, Gunnison, Hinsdale, Montrose, Ouray, San Miguel, Archuleta, Dolores, La Plata, Montezuma, San Juan, Park, Teller, Chaffee, Custer, Fremont, Lake		2178	1951
8. Southern Colorado	Alamosa, Conejos, Costilla, Mineral, Rio Grande, Saguache, Huerfano, Las Animas, Baca, Bent, Crowley, Kiowa, Otero, Prowers		2523	2316
9. Northeastern Plains	Cheyenne, Elbert, Kit Carson, Lincoln, Logan, Morgan, Phillips Sedgwick, Washington, Yuma		2470	2354
STATE TOTAL	All 63 counties.	1985	1985	

Treatment of Denver-Metro Area Counties. Net migration and population for the six counties within the Denver metropolitan area -- Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson -- are calculated differently. First, assumed future levels of net migration for the metropolitan area as a whole are calculated in the same manner as described above. Then, the future populations of the region are distributed to the respective counties in a manner consistent with the distributions developed by the Denver Regional Council of Governments in their 2000 projections update, with the 2000 Census counts, and their 2005 short-term (2002) projected distributions. Accordingly, net migration for the counties within the region is adjusted to achieve these projected population totals.

For the Denver metropolitan area, the age-sex migration pattern is determined first for the area as a whole in the manner described in the paragraph before last. From this set of net migrants a certain number of net migrants by age and sex are assigned to Denver County in a manner consistent with that county's age-sex specific migration pattern and with the total required by the DRCOG projection. The remaining net migrants for each age-sex group are then distributed to the other five counties in proportion to each county's share of total net migration.

Base Year Population. The projections by age and sex are initially based on a July 1, 2000 extrapolation of the total population counted in the April 1, 2000 Census of the Population. The distribution of the population by age and sex for July 1, 2000 is the same as counted in the Census, i.e., the population of each age-sex group is scaled up or down from the April 1 count so that their total equals the July 1 total. The total population is forecast from a 2001 base determined by the Division's multivariate estimate model mentioned before.

The Treatment of "Special" Populations. In thirty counties, the model recognizes the existence of "special" populations whose demographic behaviors different than that assumed for the general population. These special populations include college students, state prison inmates, ski resort employees, and military personnel. The size and age-sex composition of special populations is projected separately based on their special characteristics derived from census and other sources. They are not subject to the mortality and fertility schedules of the cohort-component model nor the migration assumptions projected by the econometric model.

COUNTIES WITH SPECIAL POPULATIONS

COLLEGE: Alamosa, Boulder, Denver, El Paso, Gunnison, Jefferson, La Plata, Larimer, Las Animas, Logan, Mesa, Otero, Prowers, Pueblo, Rio Blanco, and Weld.
STATE PRISON: Bent, Chaffee, Crowley, Delta, Fremont, Garfield, Jefferson, and Lincoln.
SKI RESORT: Eagle, Grand, Pitkin, Routt, San Miguel, Summit.
MILITARY: Adams, Arapahoe, Denver and El Paso.

Treatment of Elderly Populations. For each estimate year (2001 - 2003) the population 65 and over is adjusted to be consistent with data on medicare enrollments. The basis of this adjustment is the ratio of the population 65 and over to medicare enrollment at the time of the 2000 Census. For these years the total population 65 and over is calculated by multiplying the 2000 ratio times the number of that year's medicare enrollers. The population 65 and over that is projected by the model is adjusted to be consistent with this total.

The Accuracy of the Projections

Actual population change is likely to differ from projected change because it is unlikely that any statistical model can completely anticipate the future. The principal source of forecast error is the discrepancy between assumptions incorporated in these projections about the components of population change, and, in particular, that regarding migration, and the actual values of these components. (For example, the projected number of new births may exceed actual births if fertility rates fall below those assumed in these projections.) Other potential sources of forecast error are the historical data and current estimates used to calibrate the model. (For example, a projection may be too low if there was a significant underenumeration of an area.) Generally, projections for longer time periods and for areas with more volatile population trends will prove to be poorer forecasts than those for the near future and for larger areas with more stable population trends.

A special problem with these current projections is that the age-sex distribution of the migrants, and the labor force participation rates are all based on 1990 data. These variables will be updated in the coming year on the basis of data available from the 2000 Census.

Below is a series of comments on the reasonableness of likely accuracy of each component of the model used in preparing these projections.

Survival Rates. Data on current mortality levels and projections of future trends are probably the most accurate part of the cohort-component projections. Current levels are estimates from records of resident deaths by age and sex provided by the Colorado Department of Health. There is relatively little variation in mortality levels by region or over time. Changes in mortality are likely to follow the slight improvement assumed in these projections.

Fertility. While current estimates of fertility have a high degree of accuracy, there is substantial variation in fertility rates among different regions of the state and there has been substantial variation in fertility levels in past decades. If actual fertility diverges from the levels assumed in these projections, this divergence will have a significant impact on the projections for the young age groups but a relatively small impact on the projection of total population in the near future.

Migration. In this projection system, migration is determined by projected changes in employment. Thus, the process begins with a projection of employment. Then, projected changes in employment are used to project changes in the demand for labor. Finally, changes in the demand for labor are balanced by changes in supply which, after accounting for projected changes in labor force participation of the resident population, is achieved by migration in or out of the region. As can be appreciated, there is the potential for error in the assumptions used at each step in this process:

Nobody knows with any certainty or precision the future course of our international and national economies and the exact role Colorado and each of its counties will play within such prospective developments. However, the State forecast ultimately chosen by the Center for Business and Economic Forecasting and the Colorado Division of Local Government has been prepared within the context of national projections prepared by the U. S. Bureau of Economic Analysis and Fair Associates, a national economic forecasting firm, plus information from a variety of other national and local sources. The regional and county projections were prepared on the basis of studies by BEA and CBEF and the evaluation of many experts including those of the Labor Market Information section of the Colorado Department of Labor and Employment. Thus, the employment forecasts used here, are consistent with the views of a wide range of experts regarding future growth in Colorado counties given past trends and current developments.

The accuracy of the projections of the labor force supply of a county are determined by the accuracy of the estimates and forecasts of the population, and in particular by age and sex, and that of the labor force participation rates that are projected for each age-sex group. Further, an undercount of the population can lead to an underestimate of the labor supply and given a demand for labor can overstate the need for new migrants. Data on labor force participation have been prepared for considerable age-sex detail and are tied to national trends for each group. However, they are based on 2000 data.

The migration forecasts produced by this economic-demographic approach are reviewed by professionals in each of the regions throughout the State. The numbers are evaluated against recent trends regarding migration in each county and in the context of expected future economic and residential developments.